General Principles of Pathophysiology

The Normal Cell

Homeostasis

Cellular & Tissue Response to Injury

Topics

- Discuss the structure and function of normal cells
- Describe the mechanisms for the general maintenance of homesostasis
- Discuss the general responses to injury

Cellular Functions

- Organization
- Metabolism
  - Catabolism
  - Anabolism
- Responsiveness
  - Conductivity
- Movement
- Reproduction
- Growth
- Differentiation
- Respiration
- Secretion
- Excretion

Cell Kingdoms

- Prokaryotes
  - bacteria
- Eukaryotes
  - plants, animals, fungi

Building Blocks of Life

- Amino Acids -> Proteins
  - Structure & Function
- Nucleic Acids -> DNA / RNA
  - Information Transmission, energy storage
- Simple Sugars -> Polysaccharides
  - Energy Sources, structure
- Fatty Acids -> Lipids
  - Structure, Energy Source

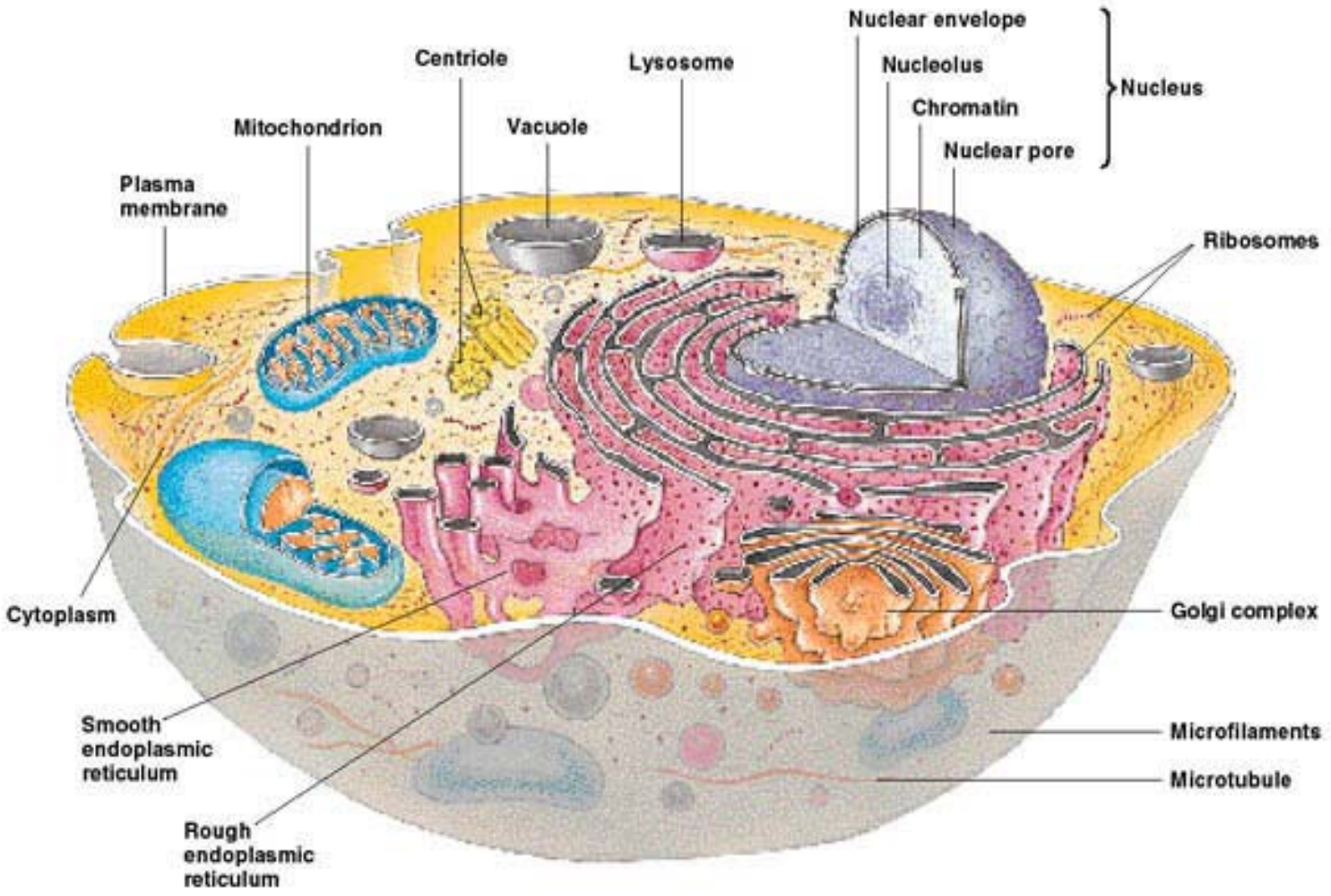
Human Genome as a Book

- There are 23 chapters, called CHROMOSOMES
- Each chapter contains several thousand stories, called GENES
- Each story is made up of paragraphs, called EXONS
- Each story is interrupted by advertisements called INTRONS
- Each paragraph is made up of words, called CODONS.
- Each word is written in letters called BASES

Cellular Components

- Phospholipid bilayer
- Membrane proteins
- Cytoplasm
- Nucleus
- Ribosomes
- Mitochondria
- Endoplasmic Riticulum
- Golgi Apparatus
- Lysosomes

Generic Eukaryotic Cell



System Integration

- Homeostasis
- Homeo = alike, same
- Stasis = always, staying

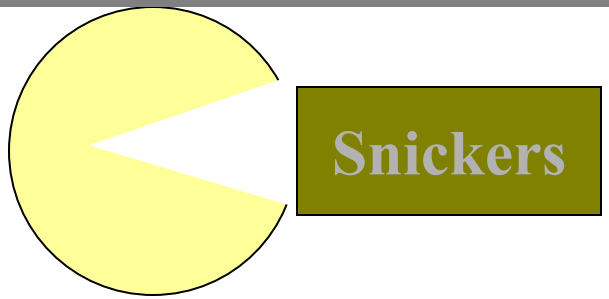
Energy Needs of Homeostasis

- Endothermic vs Exothermic Reactions
- Spontaneous vs Nonspontaneous Reactions
- ‘Coupling’
- Metabolism
  - Catabolism
  - Anabolism

Feedback Loops

- Negative
  - Opposes a change
- Positive
  - Enhances a change

Feedback Loop Example



Snickers

⇑ Blood Glucose

Pancreas ⇑ Insulin Secretion

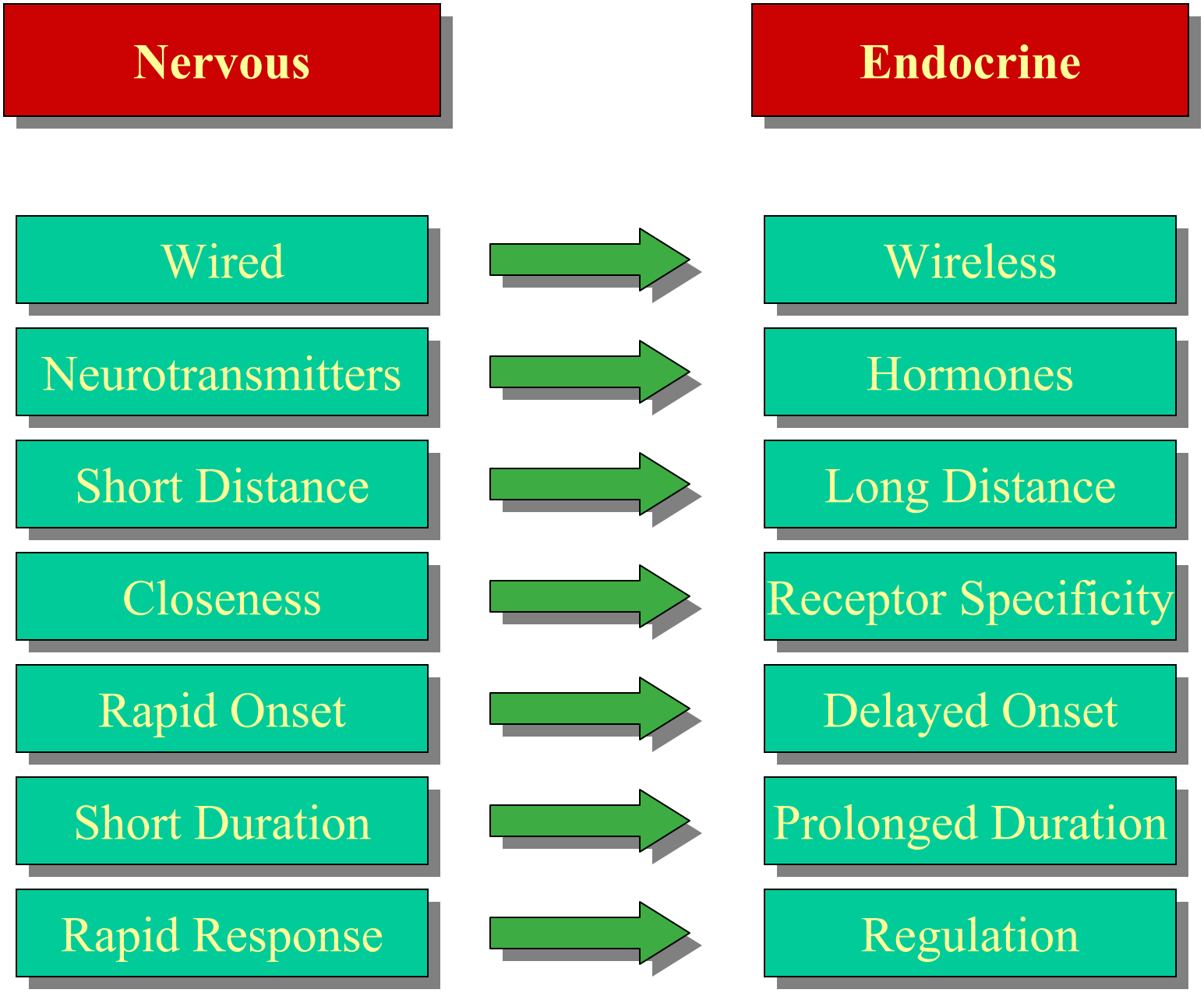
⇑ glucose transport
⇑ glycogen storage

⇓ Blood Glucose

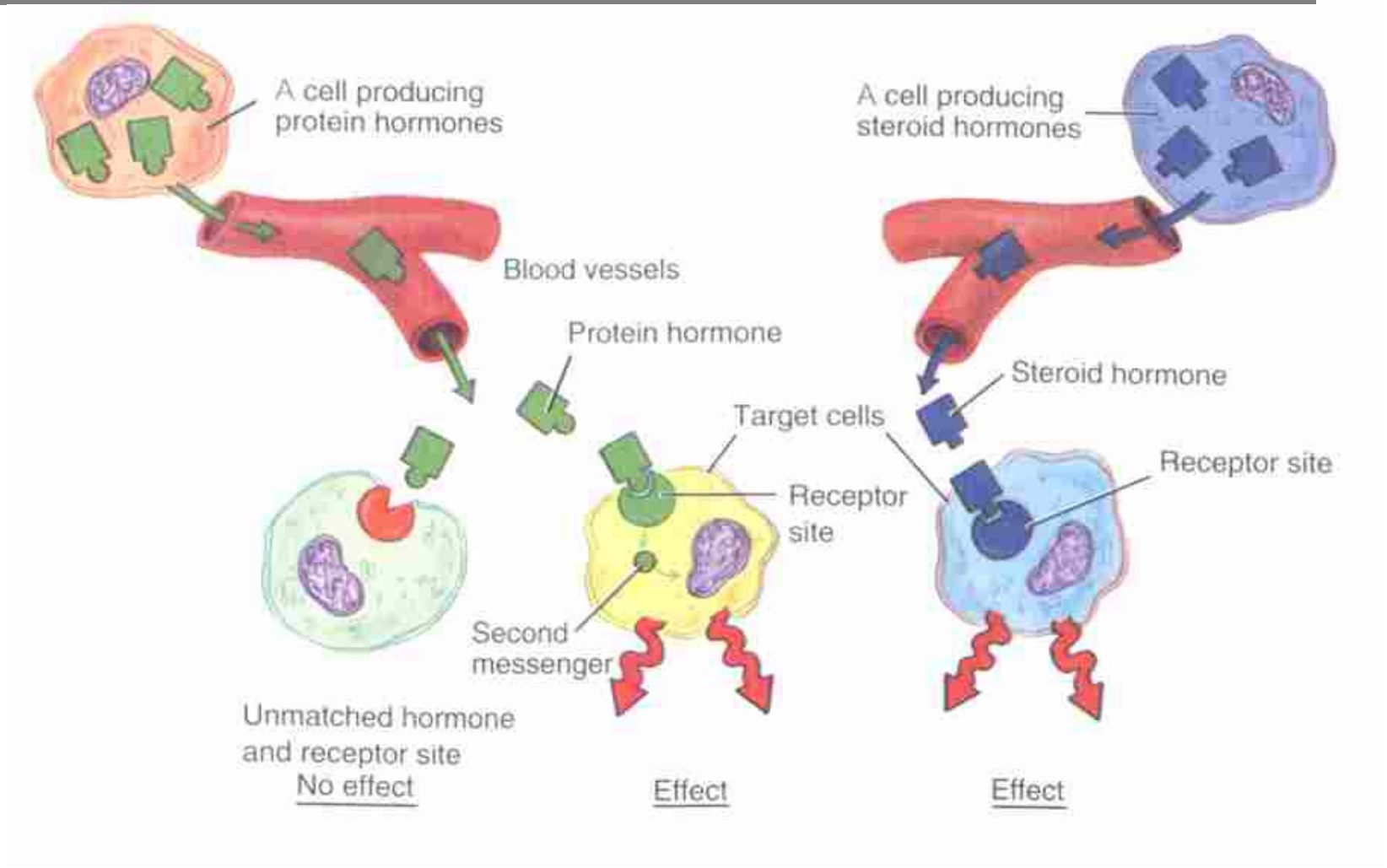
⇑ Hunger

Methods of Communication

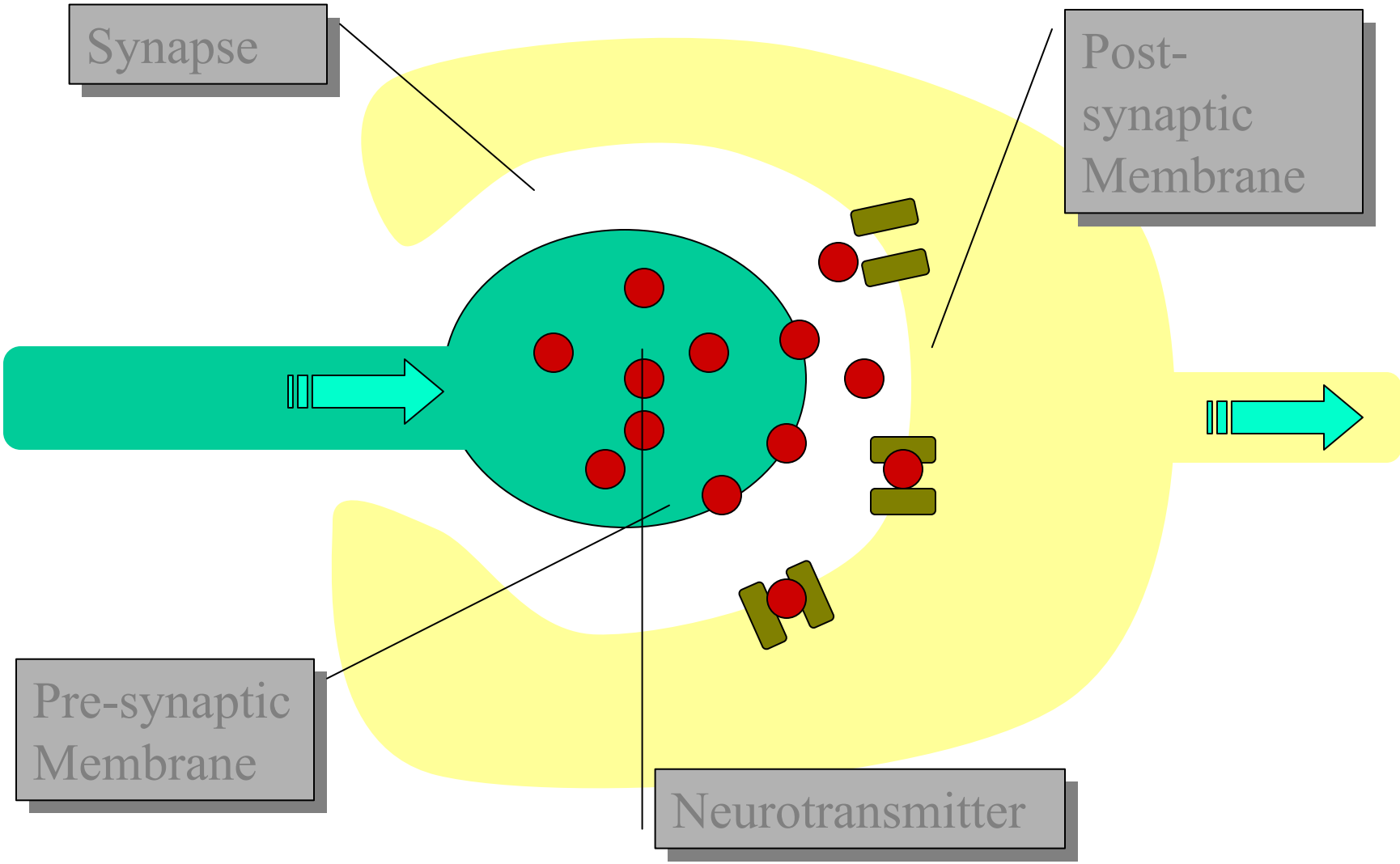
- Endocrine
  - Hormones
- Nervous
  - Neurotransmitters


Nervous
Endocrine
Wired
Wireless
Neurotransmitters
Hormones
Short Distance
Long Distance
Closeness
Receptor Specificity
Rapid Onset
Delayed Onset
Short Duration
Prolonged Duration
Rapid Response
Regulation

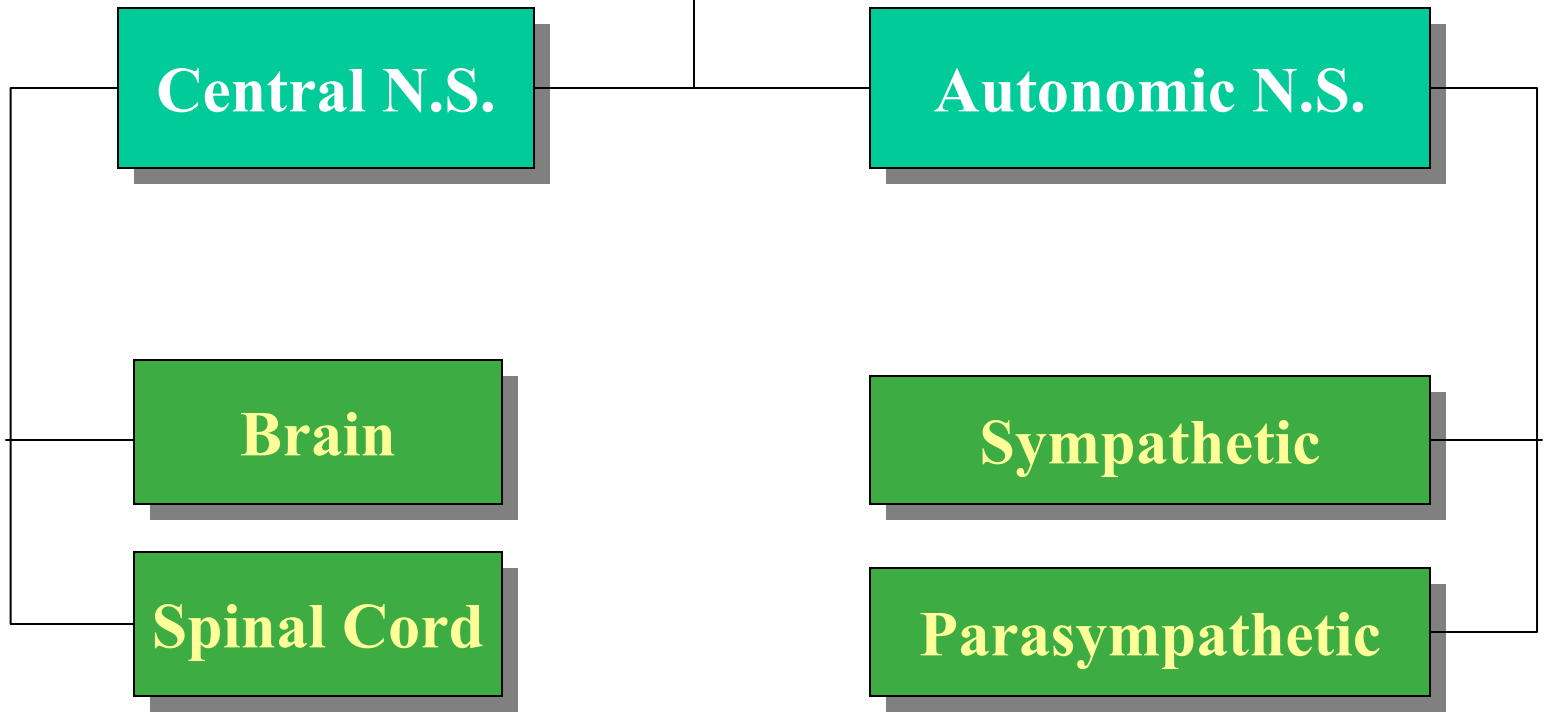
Mechanism of Action



Synaptic Transmission



Nervous System



Autonomic Nervous System

Sympathetic		Parasympathetic
‘Fight or Flight’	⟷	‘’Feed or Breed’
Activation	⟷	Restoration
Thoracolumbar	⟷	Craniosacral
Adrenergic	⟷	Cholinergic
Norepinephrine	⟷	Acetylcholine

Sympathetic Receptors

	alpha	beta
1	Constriction (⇑ Peripheral Vascular Resistance)	⇑ Contractility ⇑ Automaticity (heart rate)
2	Inhibit further NE Discharge	Bronchodilation Vasodilation

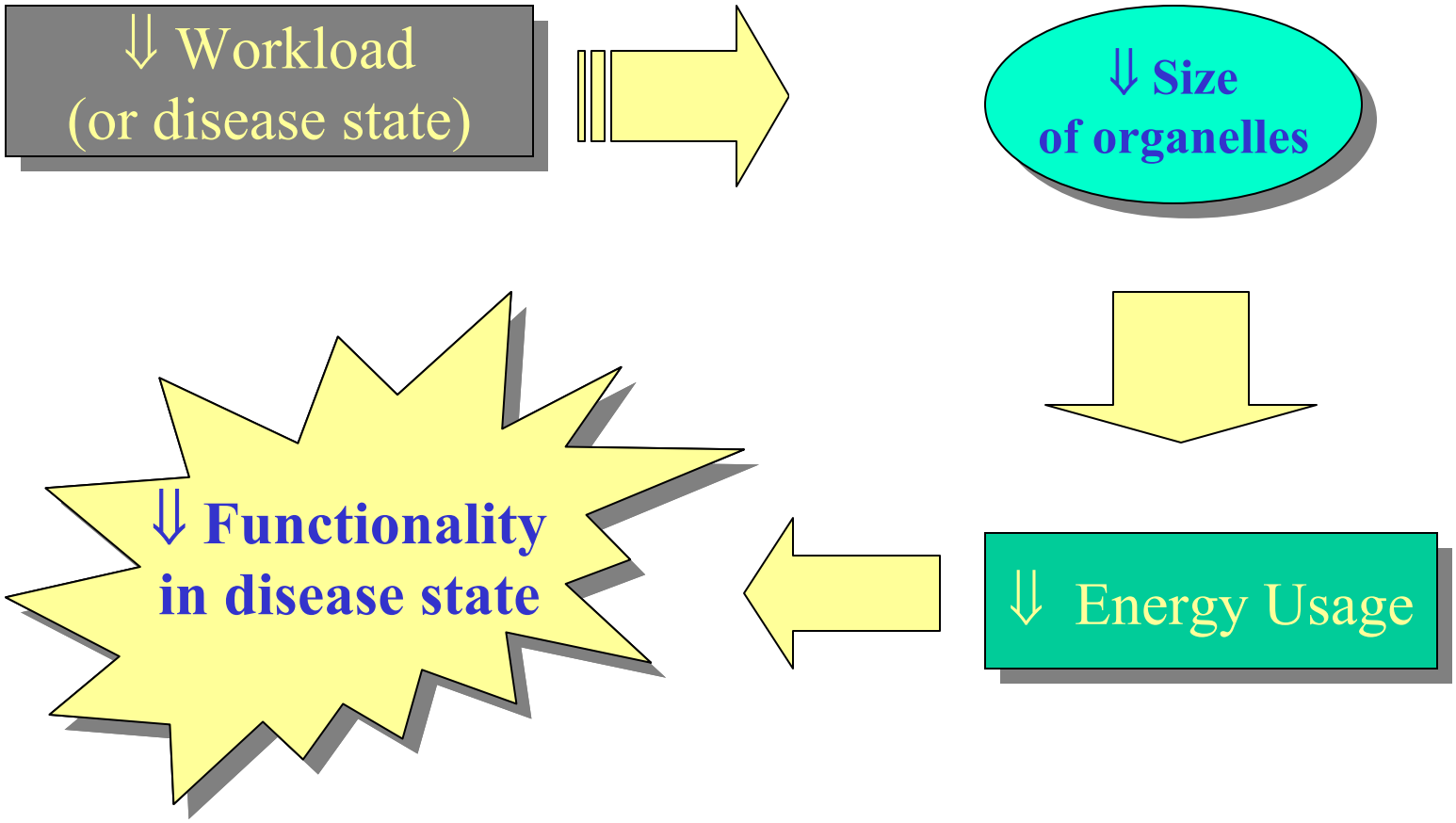
General Response to Injury

- Cellular Adaptation
- Mechanisms of Cell Injury
- Manifestations of Cell Injury
- Cellular Death

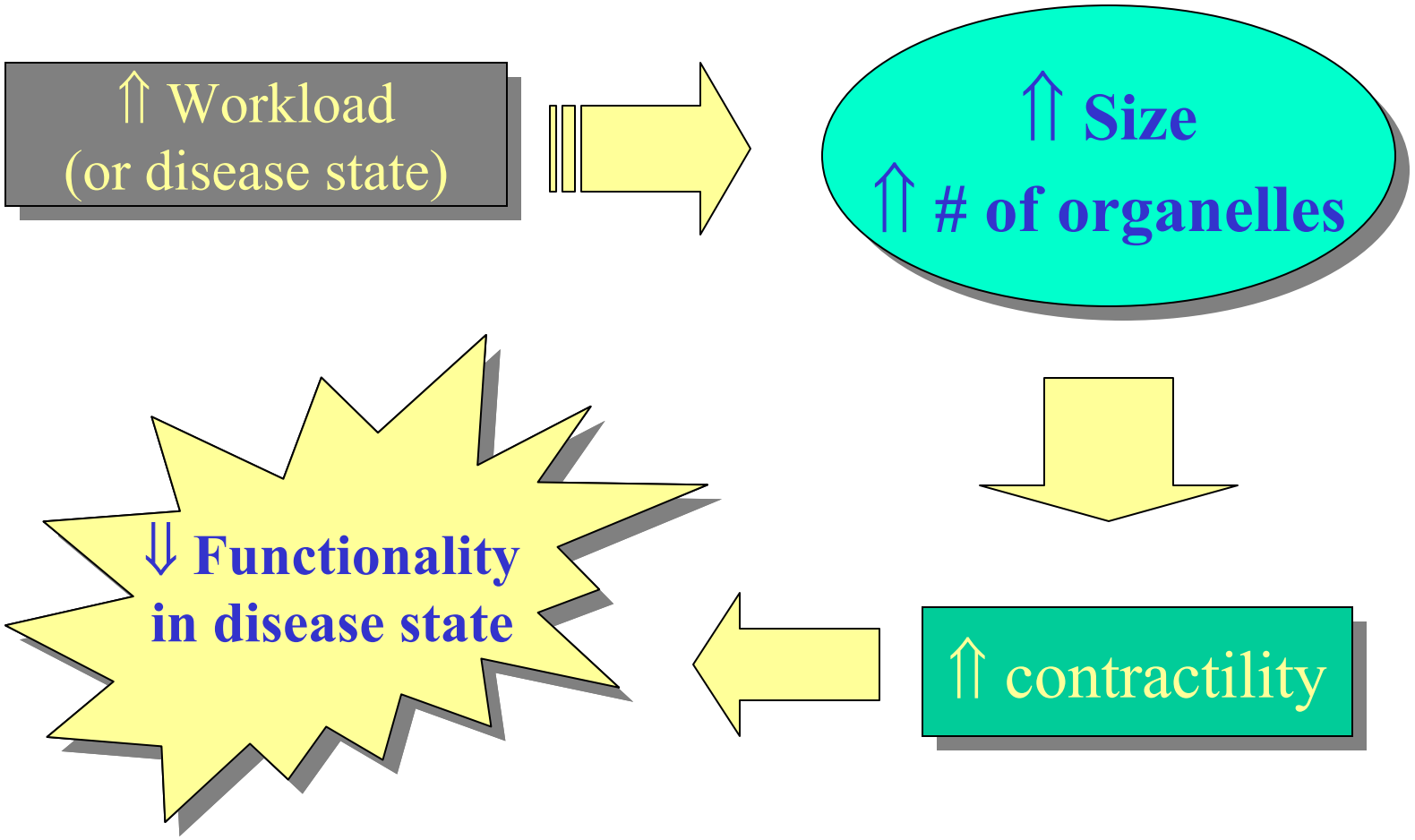
Cellular Adaptation

- Atrophy
- Hypertrophy
- Hyperplasia
- Dysplasia
- Metaplasia

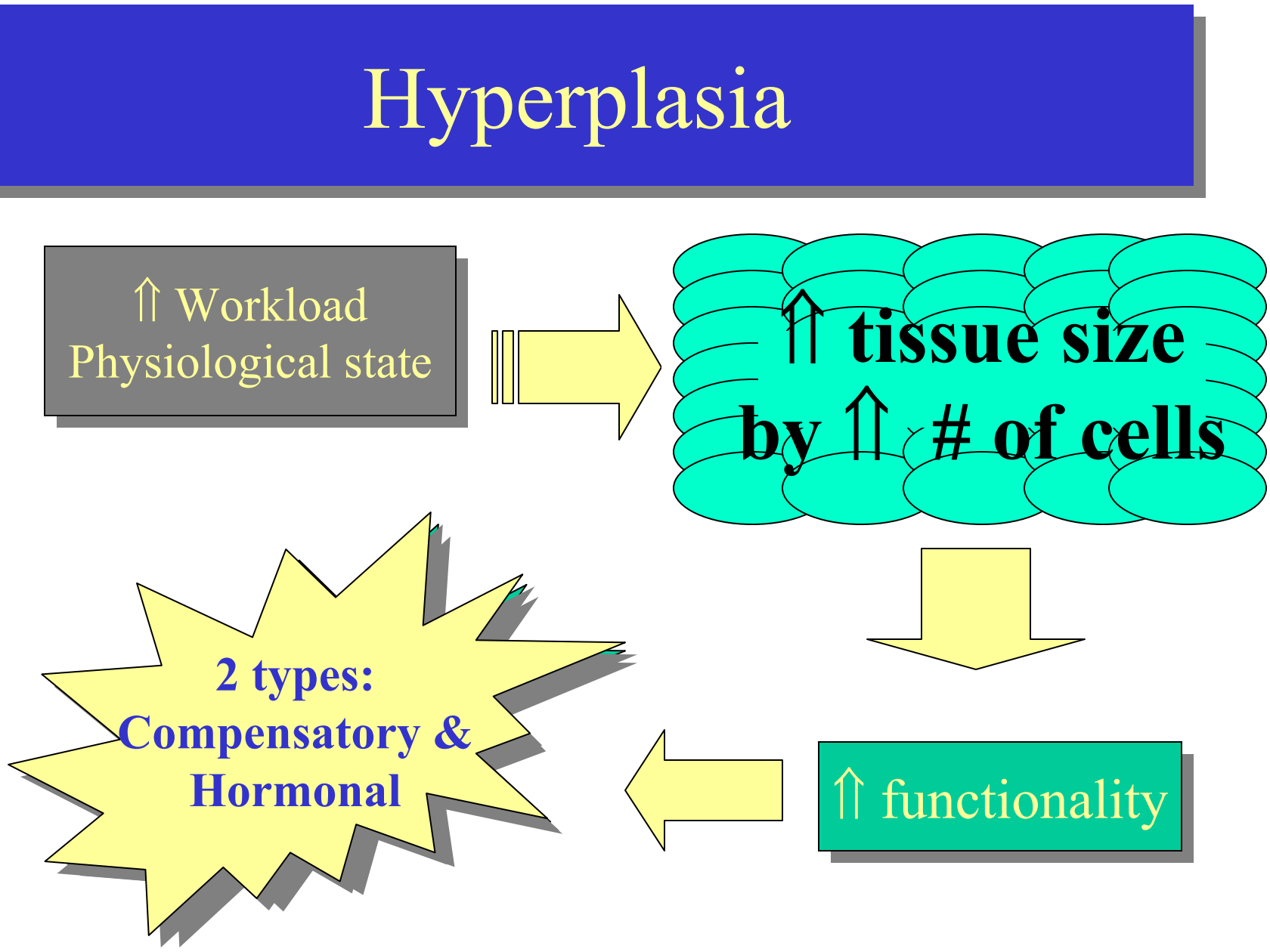
Atrophy


⇓ Workload
(or disease state)
⇓ Size
of organelles
⇓ Energy Usage
⇓ Functionality
in disease state

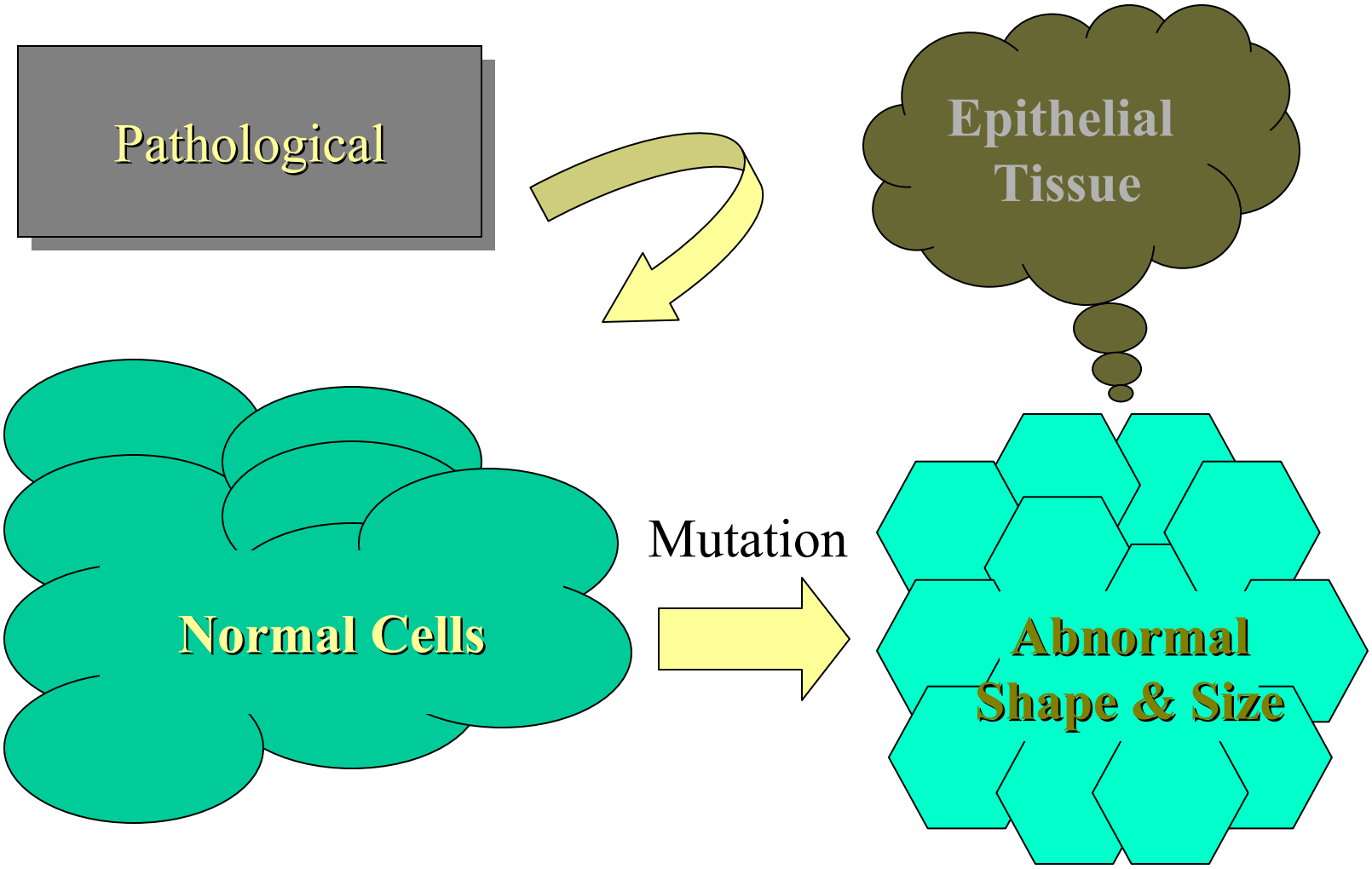
Hypertrophy



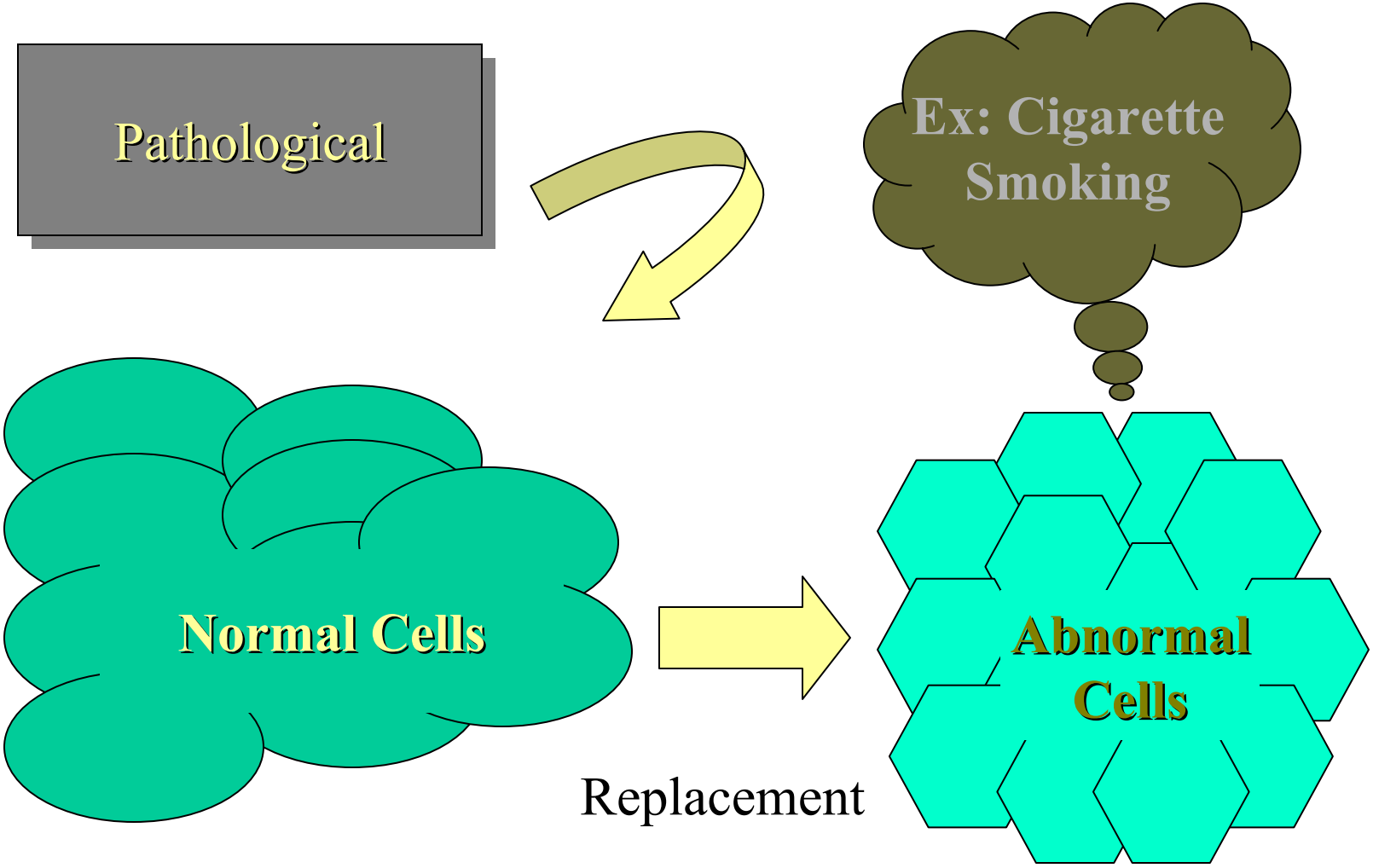
Hyperplasia



Dysplasia


Pathological
Epithelial Tissue
Normal Cells
Mutation
Abnormal Shape & Size

Metaplasia


Pathological
Ex: Cigarette Smoking
Normal Cells
Abnormal Cells
Replacement

Mechanisms of Injury

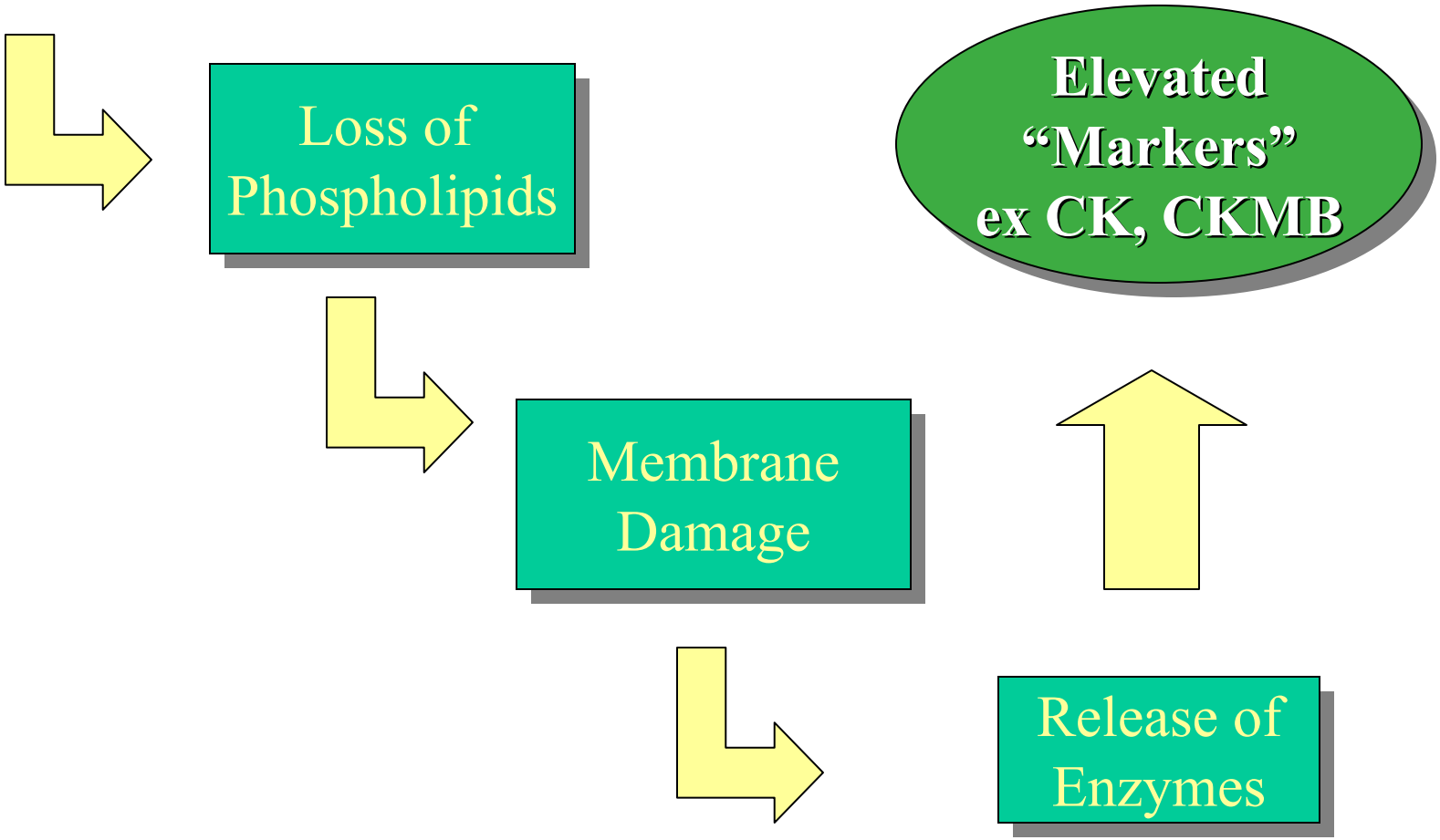
- Hypoxic
- Chemical
- Structural
  - (trauma…tons next semester!)
- Infectious
- Immunologic / Inflammatory

Hypoxic Injury

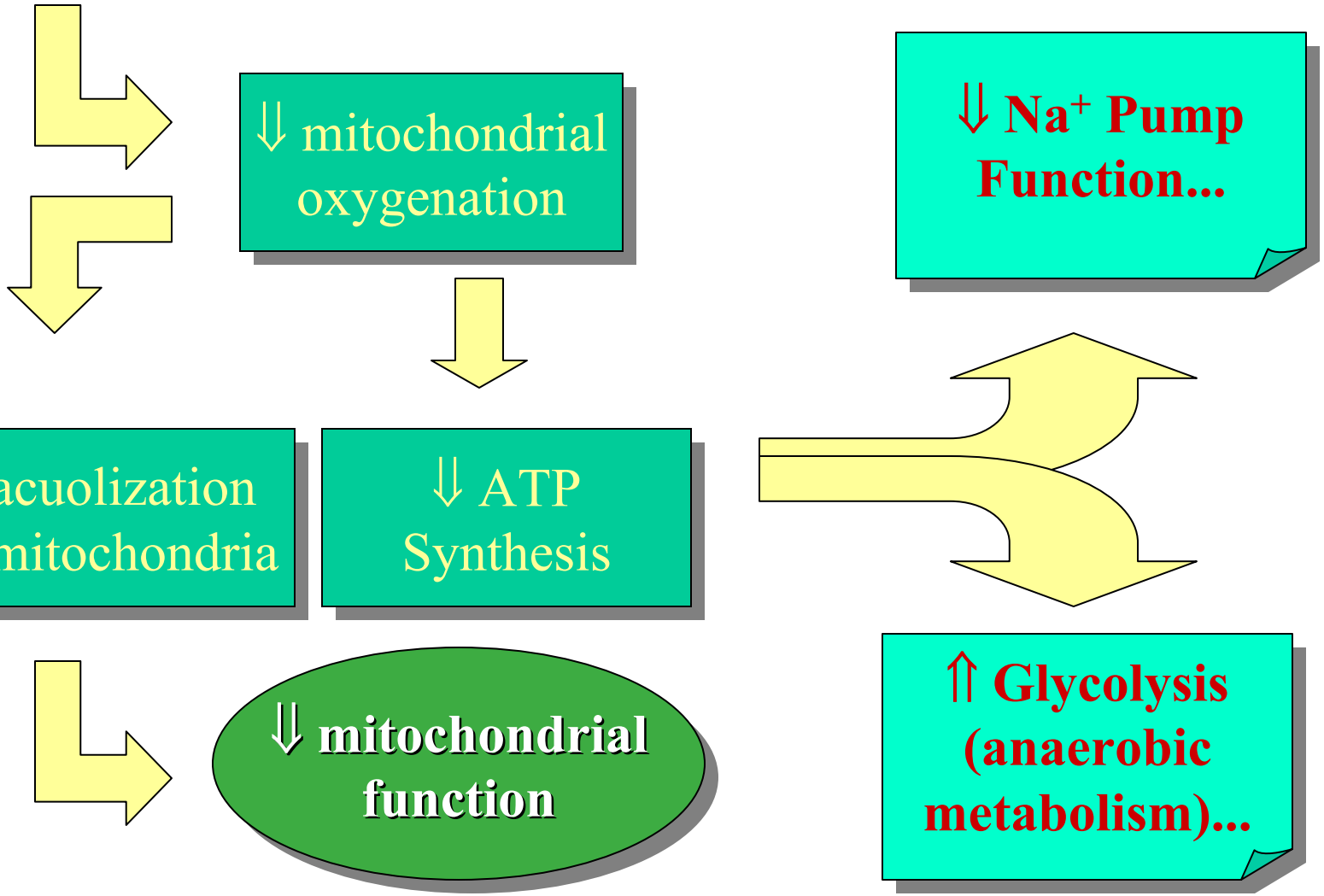
- ⇓ Atmospheric Oxygen
- Loss of Hb
- ⇓ Hb function (CO)
- ⇓ erythropoiesis
- ⇓ Respiratory Function
- ⇓ Cardiovascular Function

Most Common Cause of Cellular Injury!

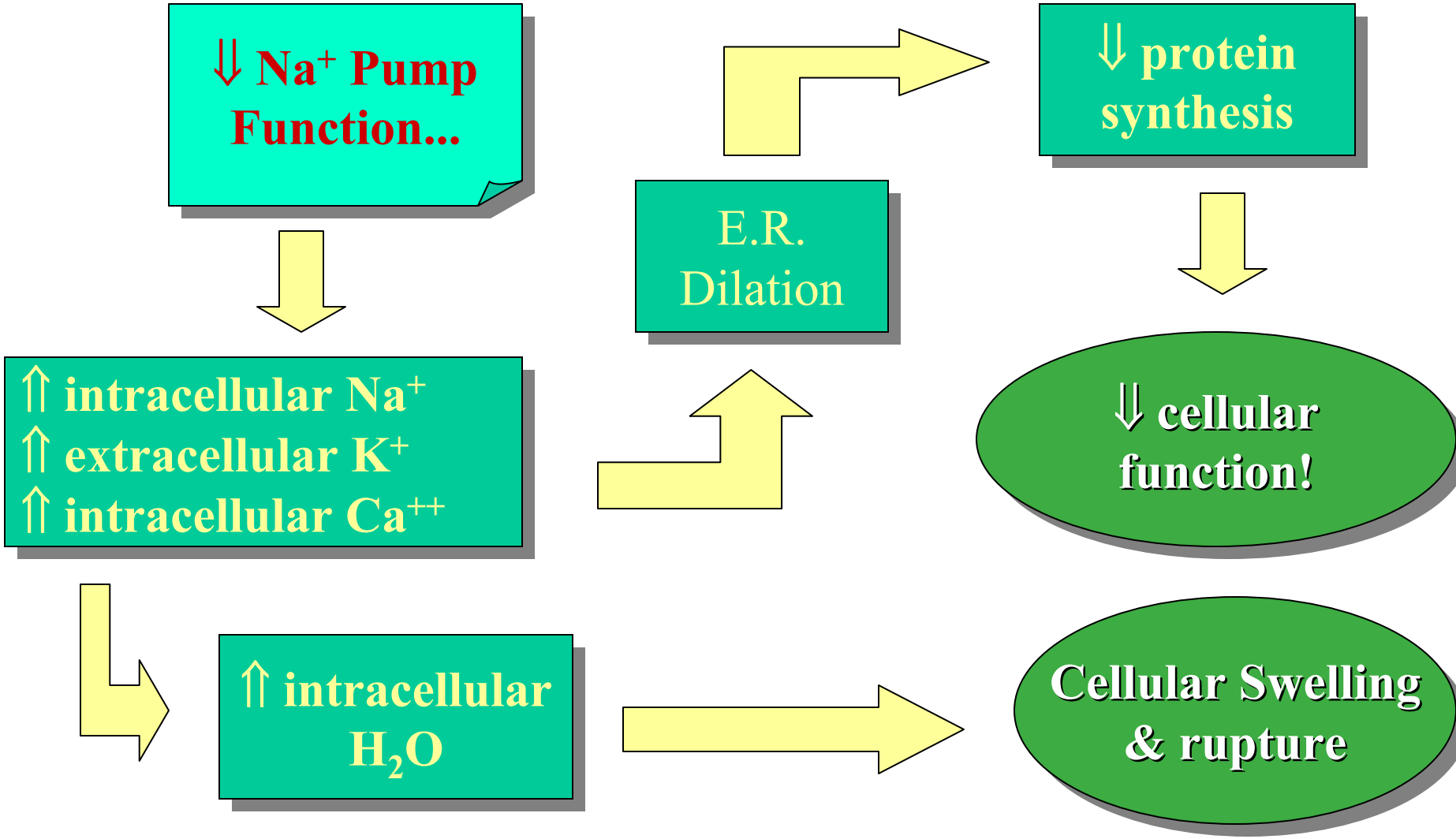
Hypoxic Injury (pathway 1)



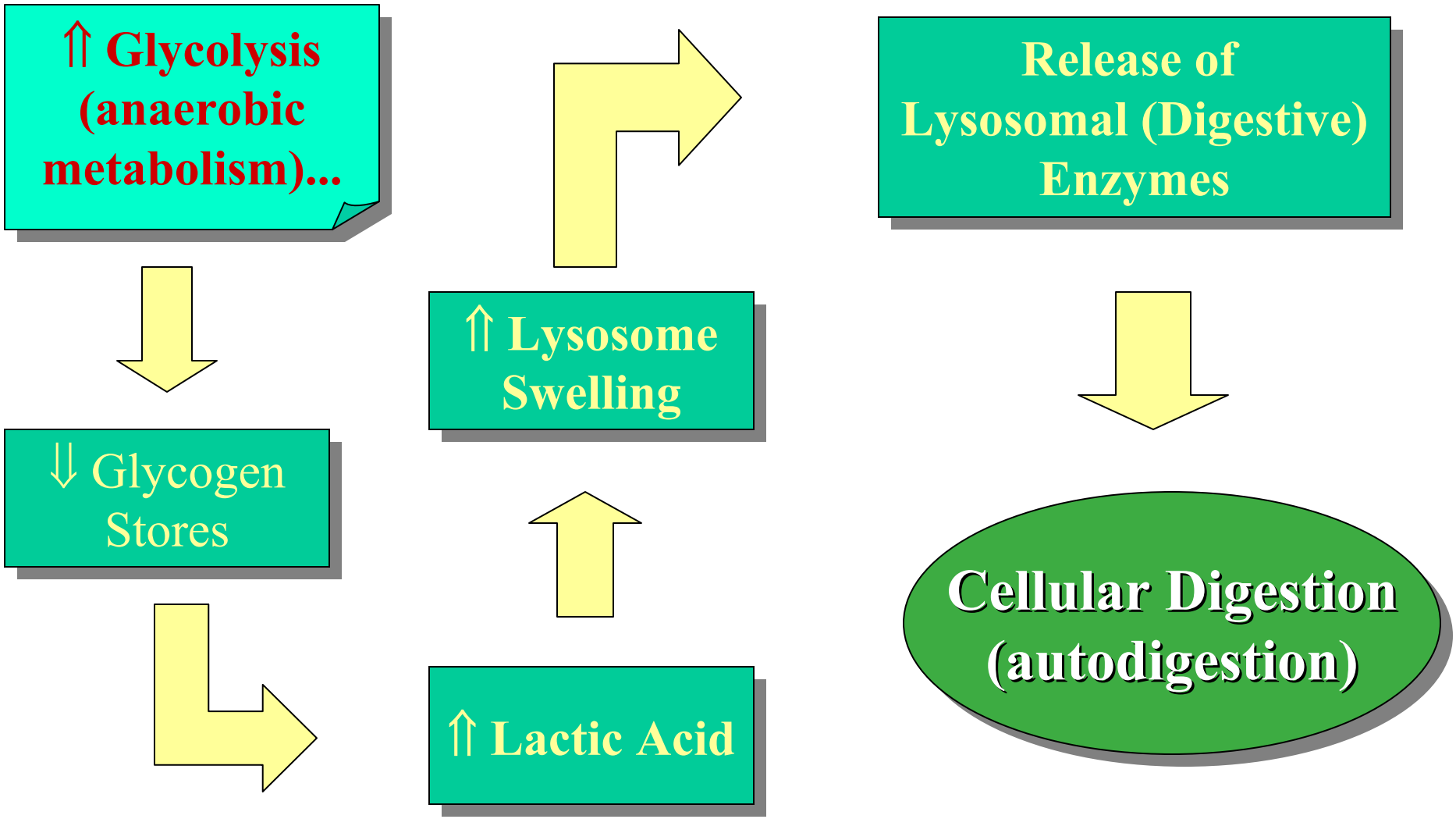
Hypoxic Injury (pathway 2)



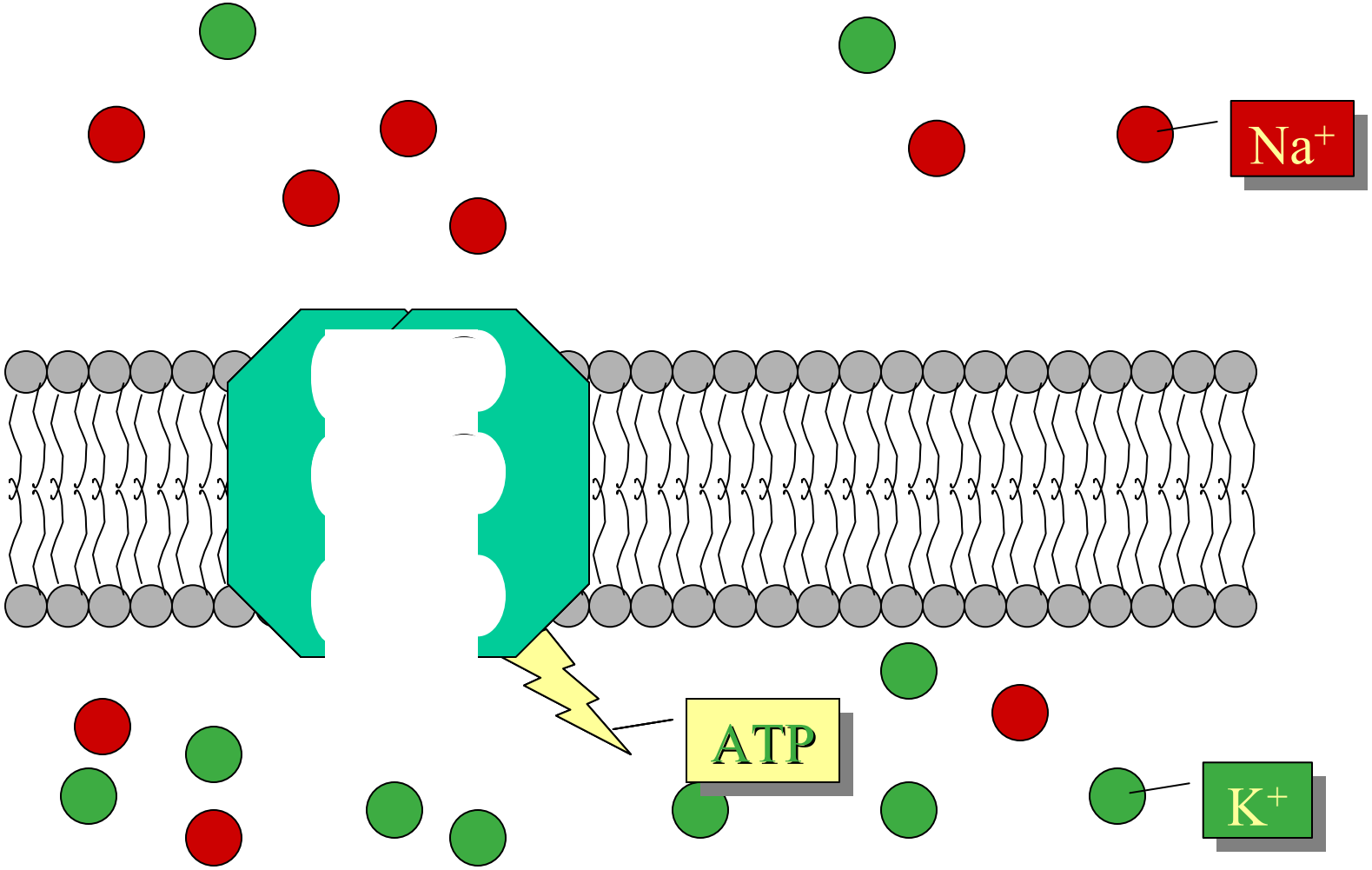
Hypoxic Injury (pathway 2)



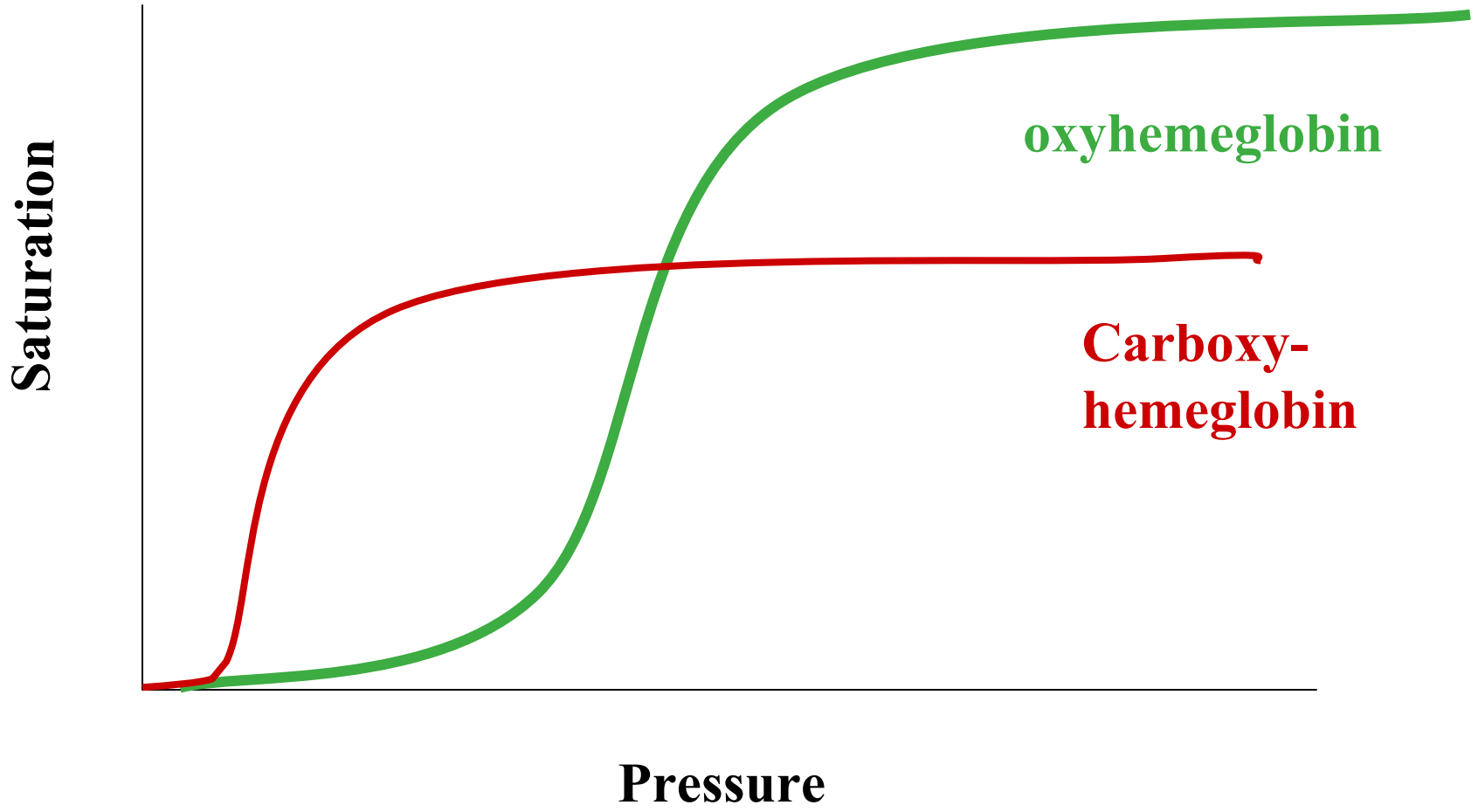
Hypoxic Injury (pathway 2)



Na^+ K^+ ATP pump

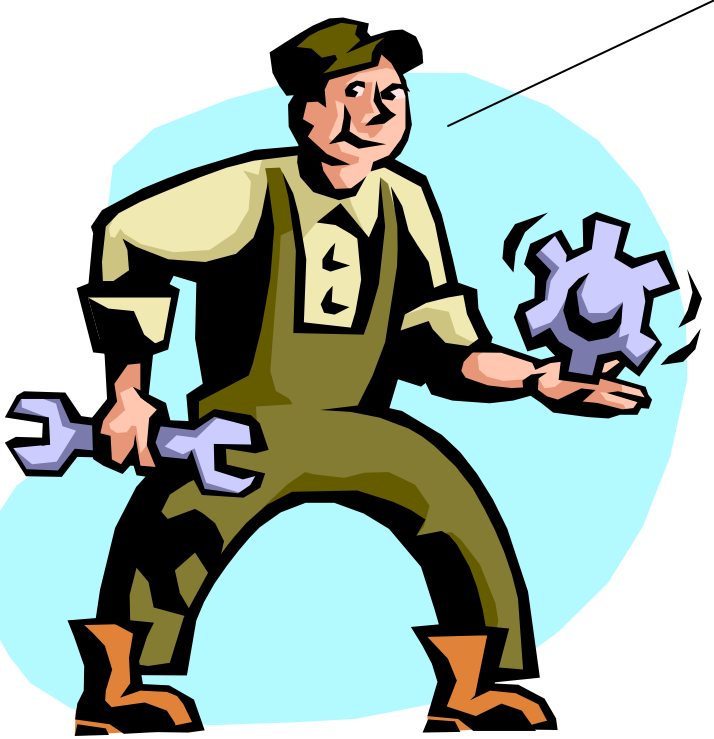


Chemical Injury



Manifestations of Injury

- Cellular Swelling



Cool
Graphics
To come!

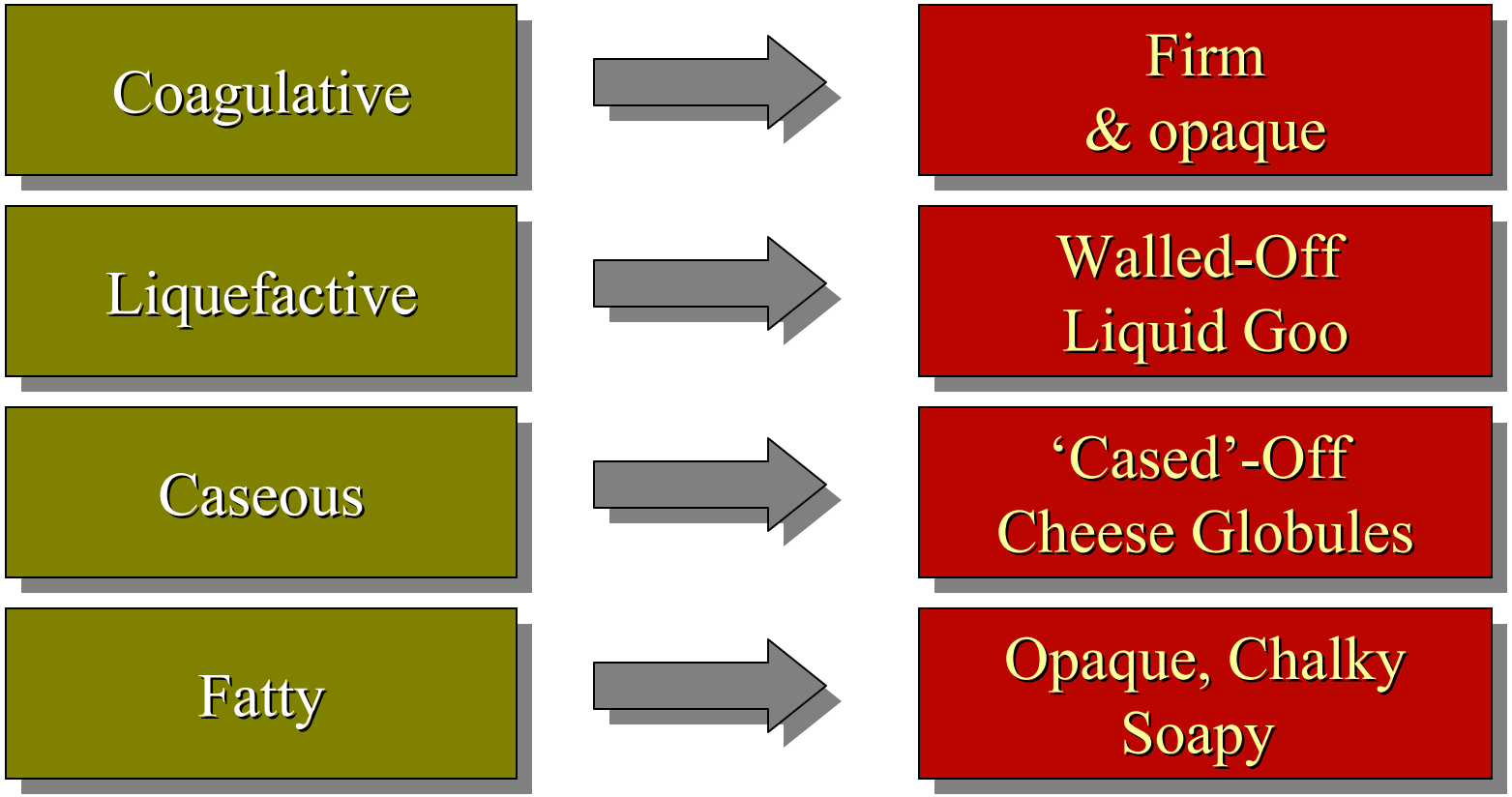
Physiological Cell Death

Apoptosis → ‘Programmed Suicide’

Normal to process of cell Replacement & Development!

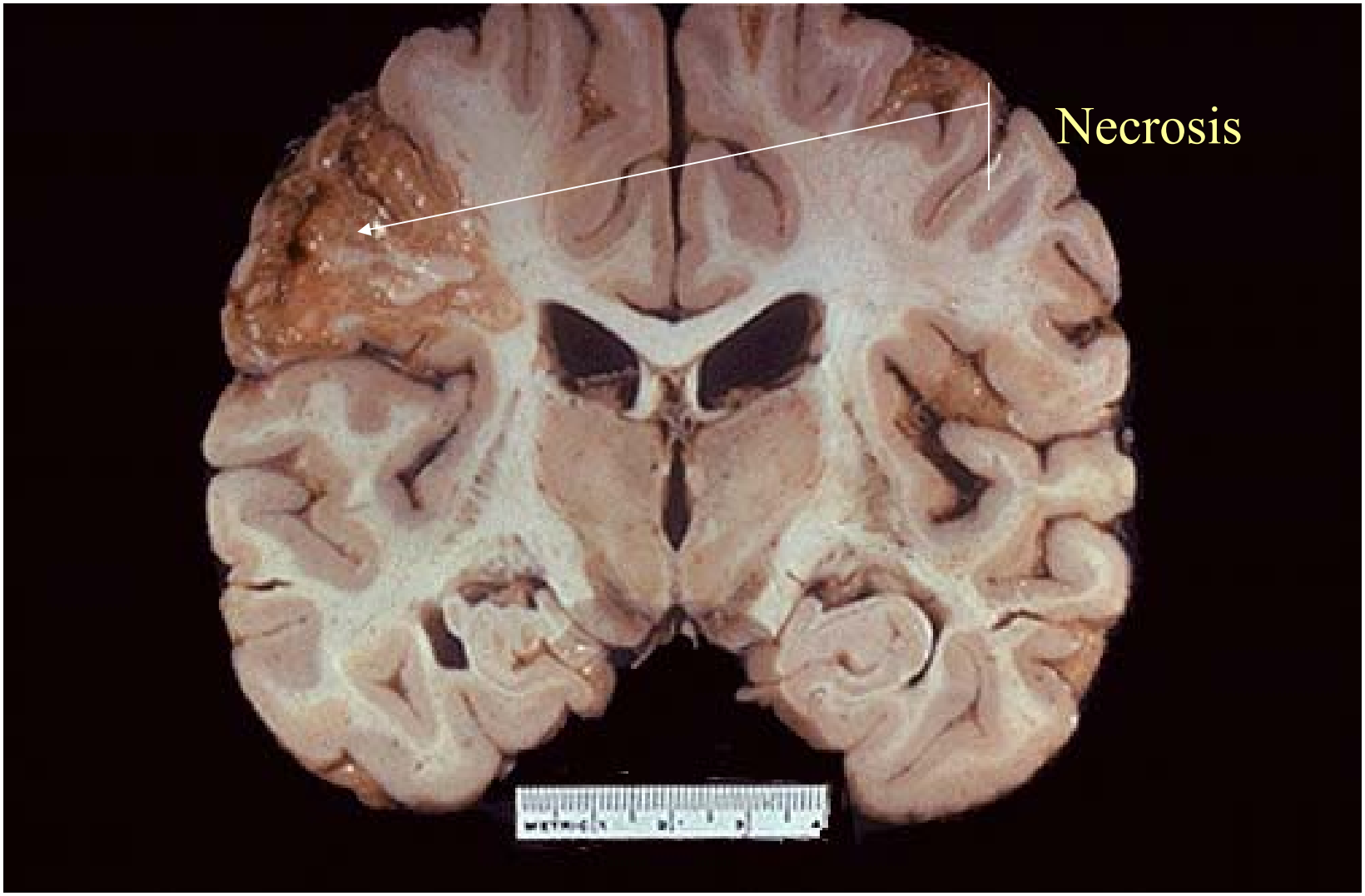
Balance between the “DO IT!” and “DON’T DO IT!” voices…

Necrotic Cell Death (pathological)



Coagulative Necrosis - Kidney

Liquefactive Necrosis - brain

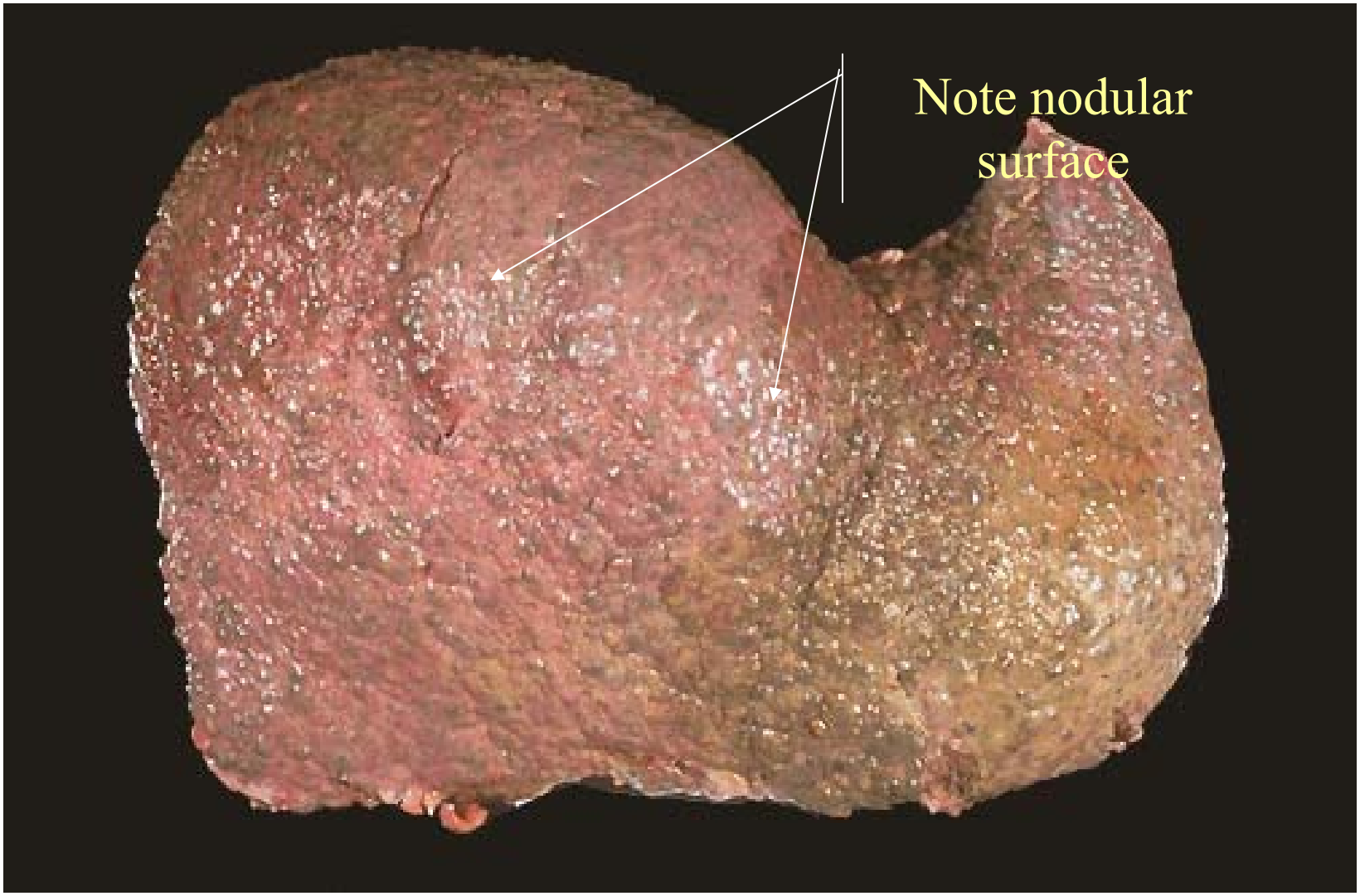


Caseous Necrosis

Typical of TB
tubercule

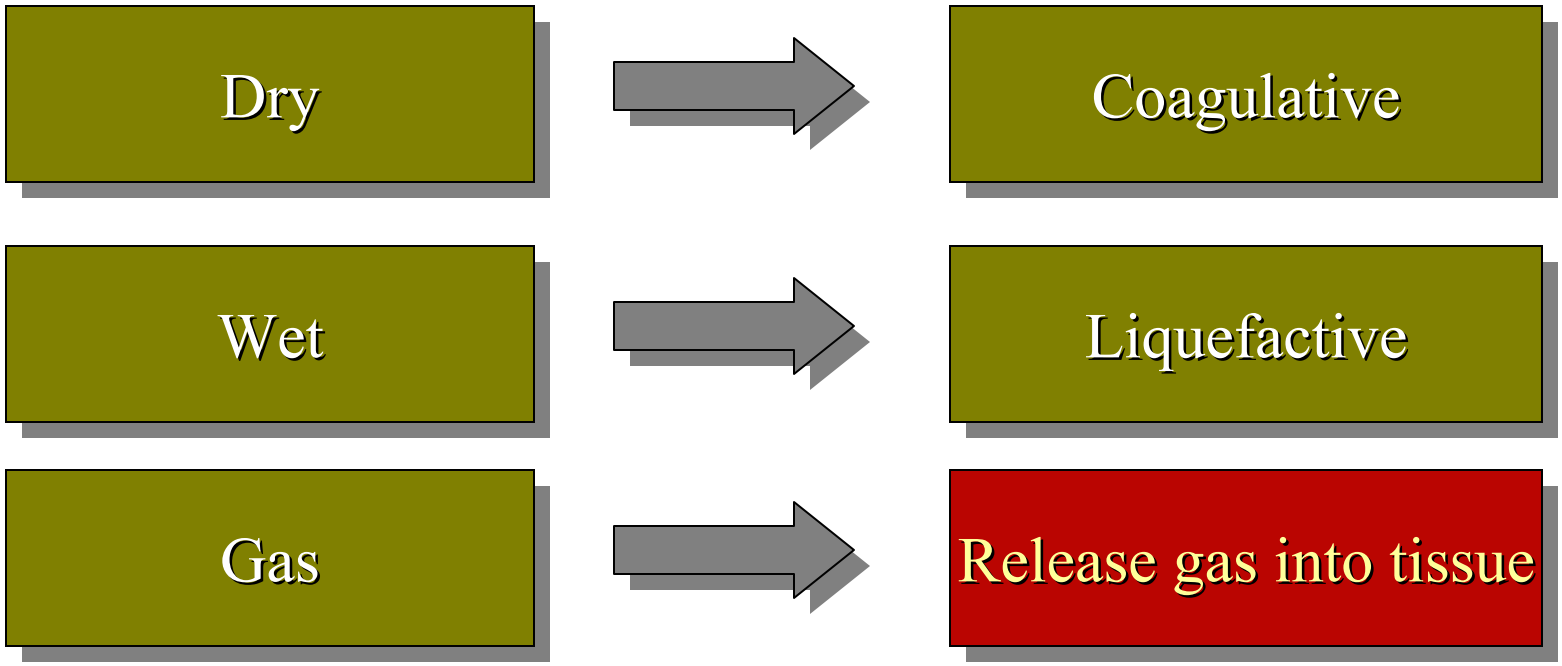
Fatty Necrosis - pancreas

Cirrhosis of the liver



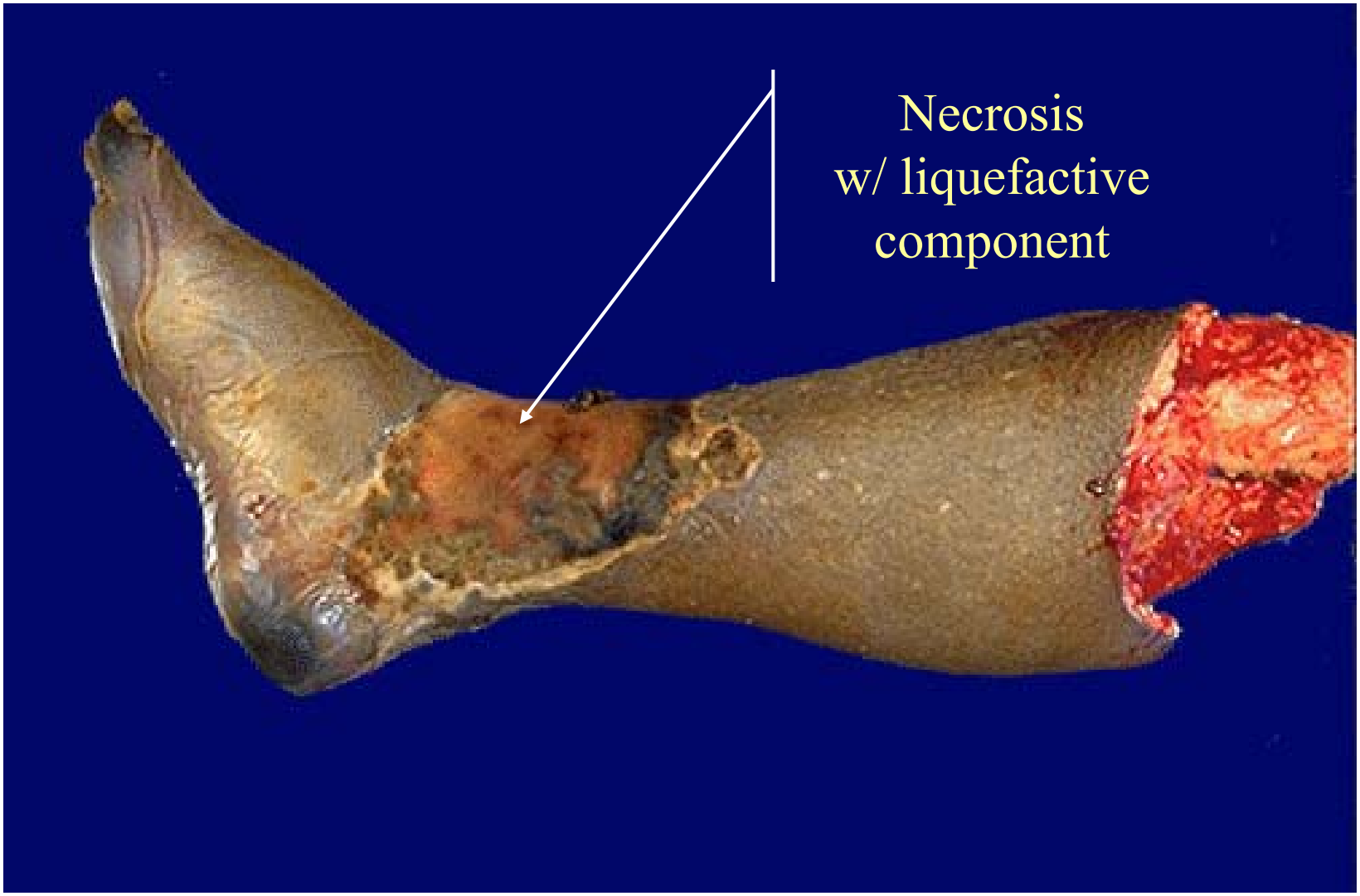
Gangrene

Caused by severe hypoxic injury



Dry Gangrene

Wet Gangrene 2º to diabetes



Web Resources

- Cell Membrane:
  - http://www.d.umn.edu/~sdowning/Membranes/lecturenotes.html#anchor360899
- Sodium Potassium ATP pump:
  - http://arbl.cvmbs.colostate.edu/hbooks/molecules/sodium_pump.html
- Kimbal's Biology Page(s): You want it, he's got it!:
  - http://www.ultranet.com/~jkimball/BiologyPages/T/TOC.html

Web Resources

- Virtual Library of Cell Biology:
  - http://vl.bwh.harvard.edu/
- On-line pathophysiology course:
  - http://sonser4.nur.uth.tmc.edu/patho/